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12

REPORT ON THE GEOPHYSICAL DESCRIPTION AND AVAILABLE DATA ASSOCIATED WITH ROCKET PF-NJ-NJ-90

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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

An Honest John Nike Javelin rocket was launched at 06:33:09 UT on March 11, 1975 from Poker Flat Research Rocket Range. This rocket reached an apogee altitude of 183.1 km with a total flight time greater than 370 seconds. The payload was successfully recovered. The rocket was launched into the eastward electrojet and penetrated into the region between the eastward and westward electrojets thirty minutes prior to an 800γ negative bay in H at College. The sky at Poker Flat was partly cloudy; at Fort Yukon mostly clear, and at Ester

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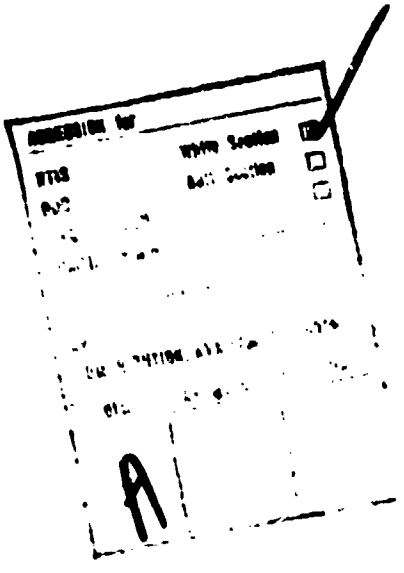
20. Dome completely overcast. No meridian scanning photometer data were obtained at Ester Dome and a camera malfunction at Ft. Yukon makes data analysis difficult although analog tape data are available if a more detailed study of this event warrants the additional effort. All sky camera data does permit a description of the general auroral activity during this event.



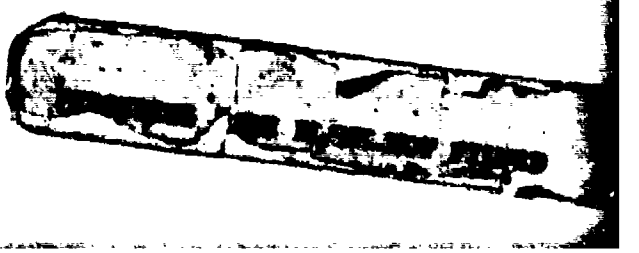
Summary

The PF-HF-NJ-90 rocket launched 06:33:09 UT, March 11, 1975, traversed an auroral rayed arc as seen from Poker Flat and Ft. Yukon. The aurora remained relatively stable during the rocket flight, but small scale changes occurred within the arc. The general situation appears to be that the rocket was launched into the eastward electrojet and traversed the region between the eastward and westward electrojets poleward of the high energy electron trapping boundary. A more detailed analysis of the ground data, although hampered by cloudy skies at all sites, could be made to help evaluate the on-board rocket data.

PREFACE

The High Altitude Effects Simulation (HAES) Program sponsored by the Defense Nuclear Agency since the early 1970 time period, comprises several groupings of separate, but interrelated technical activities, e.g., ICECAP (Infrared Chemistry Experiments--Coordinated Auroral Program). Each of the latter have the common objective of providing information ascertained as essential for the development and validation of predictive computer codes designed for use with high priority DoD radar, communications, and optical defensive systems.

Since the inception of the HAES Program, significant achievements and results have been described in reports published by DNA, participating service laboratories, and supportive organizations. In order to provide greater visibility for such information and enhance its timely applications, significant reports published since early calendar 1974 shall be identified with an assigned HAES serial number and the appropriate activity acronym (e.g., ICECAP) as part of the report title. A complete and current bibliography of all HAES reports issued prior to and subsequent to HAES Report No. 1 dated 5 February 1974 entitled, "Rocket Launch of an SWIR Spectrometer into an Aurora (ICECAP 72)," AFCRL Environmental Research Paper No. 466, is maintained and available on request from DASIAC, DoD Nuclear Information and Analysis Center, 816 State Street, Santa Barbara, California 93102, Telephone: (805) 965-0551.



This report, which is the fifth report under DNA Contract F19628-74C-0188 is the 36th report in the HAES series and covers technical activities performed during the period August through November 1975. The purpose of the work herein is to provide a geophysical description of the auroral and geomagnetic environment during the launch of ICECAP rocket PF-HJ-NJ-90 (IC511.21-1A); to assist in interpretation of the primary measurements obtained by the sensors onboard this specific experimental payload.

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INTRODUCTION

This report describes the general auroral activity associated with the launch of rocket PF-HJ-NJ-90 on UT March 11, 1975 at Poker Flat Research Range. Included in this report are peripheral data pertinent to the launch, atmospheric meteorology and ground station instrumentation operation.

The format is arranged in sections to facilitate locating specific information on the various types of data and instruments that were in operation. Explanatory material is included with each section for completeness.

The summary that is presented pertains only to the description of the geomagnetic activity and our evaluation of the usefulness in proceeding to detailed absolute intensity and high time resolution studies of the available ground based data.

Section 1 - Launch Parameters

This section reviews all of the pertinent details known at the time of the preparation of this report on the launch parameters of the vehicle. The specific details of the launch are listed in Table 1.

TABLE 1 Launch Resume

Vehicle Type	Honest John-Nike Javelin
Poker Flat Research Range Vehicle Code Number	PF-HJ-NJ-90
NASA or other Vehicle Code Number	1C511.21-1A
Launch Date and Time	UT March 11, 1975 06:33:09
Launch Azimuth	predicted, (actual setting) 45, (32.5)
QE	predicted, (actual setting) 83.5, (84.1)
Apogee Altitude	predicted, (actual) 200 km, (182.6 km)
Apogee Time	predicted, (actual) (225 sec)
Impact Range	predicted, (actual) 162 km, (148.81 km)
Impact Azimuth	predicted, (actual) 45, (46.75)
Impact Time	predicted, (actual) (434 sec) recovery payload
Payload Weight	340 lbs.

Table 2 lists the rocket and field line observation angles obtained from the trajectory supplied by Space Data Corporation. Listed in 10 second steps in time after the launch (T+0) are the Azimuth and Elevation angles to the vehicle and to the 100 km intercept point along the field line through the rocket as seen from Poker Flat, Ft. Yukon and Ester Dome. The magnetic field model used in this calculation is the Pogo 10-65 internal field model. The altitude of the rocket is also listed.

LOOK ANGLE DATA

(sec)	ROCKET OBSERVATION ANGLES						100 km FIELD LINE INTERCEPT OBSERVATION ANGLES						
	ESTER DOME		POKER FLATS		FT. YUKON		ESTER DOME		POKER FLATS		FT. YUKON		
T+	ELEVATION	AZIMUTH	ELEVATION	AZIMUTH	ELEVATION	AZIMUTH	ELEVATION	AZIMUTH	ELEVATION	AZIMUTH	ELEVATION	AZIMUTH	(km) ALT
060	19.6356	13.1715	77.1741	44.7040	29.3318	248.0683	33.6637	12.2056	87.1141	72.5414	42.2238	245.2558	97.80
070	23.8580	13.9356	76.7216	45.0009	36.3022	248.8653	32.5020	13.3718	83.3564	52.6660	43.9883	246.8976	72.50
080	27.2551	14.8841	76.2239	45.1827	42.3336	249.7379	31.4253	14.4297	79.5403	47.5697	45.7964	248.6868	88.42
090	30.2104	15.9079	75.6603	45.7212	47.5826	250.6560	30.4047	15.4965	75.7271	45.8117	47.7402	250.5987	99.22
100	32.8920	16.1466	75.0899	45.5172	51.9542	251.7535	29.4834	16.3244	72.3091	44.3335	49.5645	252.7908	111.34
110	34.6124	16.7126	74.7615	45.3826	55.5982	252.8337	28.6750	17.0320	69.2824	43.4157	51.2772	255.0620	122.50
120	36.2257	17.2735	74.3155	45.2701	58.7307	254.0462	27.9153	17.6998	66.4104	42.8234	53.0021	257.5506	132.64
130	37.6306	17.8813	73.8602	45.7154	61.4287	255.0126	27.2636	18.3847	63.8731	42.6425	54.6862	259.9909	141.95
140	38.8674	18.3985	73.4704	45.6434	63.7573	256.3766	26.6194	19.0556	61.4406	42.5537	56.3150	262.7284	150.32
150	39.9013	18.9255	72.8567	45.5680	65.9387	257.9644	25.9993	19.5127	59.1046	42.3649	57.9485	265.7103	157.66
160	40.8514	19.4171	72.2496	45.5073	67.6341	259.6536	25.4354	20.0193	57.0042	42.2429	59.4617	269.2659	164.05
170	40.6653	19.8842	71.6217	45.4622	69.2059	261.4717	24.9193	20.4893	55.0941	42.1754	60.8635	272.8169	169.62
180	40.7029	20.4332	70.9014	45.7204	70.6779	263.3094	24.4438	21.0226	53.2969	42.1344	62.3011	276.4764	174.15
190	40.7512	20.8695	70.1800	45.6910	71.9084	265.4836	23.9986	21.4422	51.6934	42.4062	63.4652	280.4453	177.87
200	40.5382	21.3998	69.4755	45.6496	73.1847	268.5840	23.5028	21.9352	49.9092	42.4861	64.7764	285.5269	180.24
210	40.4121	21.7008	68.8616	45.6243	74.0704	271.0283	23.1553	22.2723	48.6819	42.5277	65.5931	289.5419	182.23
220	39.5383	22.2306	67.1904	45.6875	75.1274	274.4114	22.7553	22.7927	47.2225	42.8831	66.6814	294.6932	182.79
230	39.6114	22.6317	66.4305	45.6815	75.7373	277.0789	22.4875	23.0723	46.3005	42.9654	67.2012	298.4319	183.10
240	39.0043	23.0064	65.8403	45.6611	76.3594	280.7647	22.1952	23.4022	45.2583	43.0861	67.7222	303.0127	182.16
250	38.1509	23.3356	65.2891	45.6505	76.8529	285.6053	21.8638	23.6974	44.1776	43.0853	68.0252	308.1811	180.04
260	37.2959	23.7077	62.6411	45.6128	77.2600	289.3691	21.6422	24.0266	43.4039	43.3699	68.4016	312.0189	177.64
270	36.3023	24.0775	61.2626	45.7519	77.5456	294.8236	21.3747	24.3542	42.5013	43.5502	68.6004	316.8123	173.73
280	35.0374	24.4221	59.4908	45.7131	77.6347	300.9580	21.1160	24.6578	41.6525	43.6942	68.6394	321.5639	168.86
290	33.5284	24.7299	57.4659	45.6065	77.4351	307.2625	20.8974	24.9262	40.9341	43.8392	68.5916	325.6772	162.40
300	31.9832	25.0991	55.2501	45.5995	77.0961	313.6595	20.6945	25.2190	40.2598	44.0613	68.5339	329.6643	155.65
310	30.5521	25.4511	53.3495	45.5765	76.8541	319.1394	20.5627	25.6141	39.7569	44.6165	68.8251	333.0161	149.13
320	28.7262	25.7675	50.6524	45.9720	76.3053	324.8891	20.4339	25.8606	39.3085	44.8662	68.7903	335.8838	140.61
330	26.7241	25.8631	48.0512	45.5404	75.4858	330.5063	20.2732	26.0327	38.8496	44.7204	68.3101	338.3935	131.47
340	24.6371	26.3820	44.9311	46.0709	73.3597	336.6967	20.1730	26.4212	38.4163	45.4984	68.7163	341.8697	121.66
350	22.2078	26.6779	41.2226	46.0826	71.1083	342.4182	20.0539	26.6945	38.0041	45.8121	68.6353	344.6966	110.40
360	19.5412	26.9623	37.0011	46.0717	68.0183	347.7700	19.9423	26.9596	37.6200	46.1210	68.5352	347.3852	98.17
370	16.7345	27.2266	32.3613	46.0618	63.9331	352.4372	19.8521	27.2107	37.3000	46.4351	68.4781	349.7357	85.08

TABLE 2 Look Angle Data

Section 2 - Meteorological Data

The weather summaries are given in Table 3. The data are obtained from either station logs, ASC data, or weather bureau records. Also included in Table 4 (next page) are the complete 3 hour climatology data for the month of March at the U. S. Weather Bureau Station at the Fairbanks International Airport.

TABLE 3 Weather Summary March 11, 1975

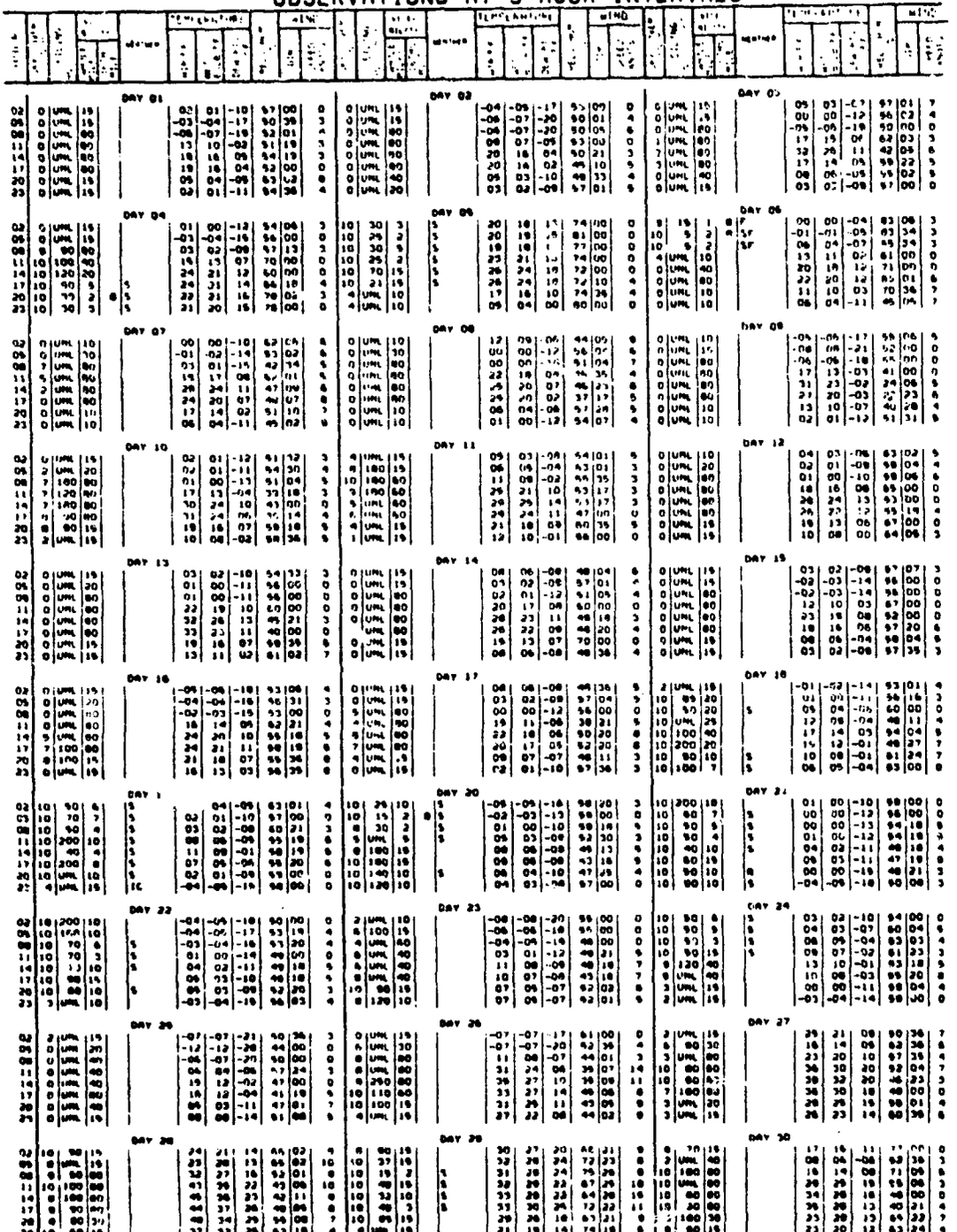
Time (UT)	Ester Dome	Poker Flat	Ft. Yukon	Mould Bay	Sachs Harbor	Inuvik
05	Partly Cloudy	Partly Cloudy	Clear	Clear		Clear
06	Cloudy	Partly Cloudy	Scattered Clouds	Clear	NO	Clear
07	Cloudy	Cloudy	Partly Cloudy	Clear	DATA	Clear
08	Cloudy	Cloudy	Cloudy	Clear	FOR	Clear
09	Cloudy	Cloudy	Partly Cloudy	Clear	THIS	Clear
10	Clear	Clear	Partly Cloudy	Clear	TIME	Clear
11	Clear	Clear	Clear	Clear		Clear
12	Clear	Clear	Clear	Clear		Clear

Table 5 gives the wind parameters at Poker Flat at the time of launch.

TABLE 5 Wind Data at Launch

Surface Wind Velocity	2.0 m/s	Az 140.4
Ballistic Wind Velocity	4.1 m/s	Az 108.4

OBSERVATIONS AT 3-HOUR INTERVALS



NOTES

CEILING COLUMN-

WEATHER COLUMN-

WIND COLUMNS-

ADDITIONAL DATA

OTHER OBSERVATIONAL DATA CONTAINED IN RECORDS ON FILE CAN BE FURNISHED AT COST VIA MICROFILM, MICROFICHE, OR PAPER COPIES OF THE ORIGINAL RECORDS. INQUIRIES RE TO AVAILABILITY AND COSTS SHOULD BE ADDRESSED TO: DIRECTOR, NATIONAL CLIMATIC CENTER, FEDERAL BUILDING, ASHEVILLE, NORTH CAROLINA 28801.

TABLE 4 3-Hour Climatological Data, March 1975

Figure 1 shows the Poker Flat Rocket Sounding data on temperature up to 60 km for the night of March 11, 1975. Launch of the meteorological rocket was at 0317 UT.

Examination of the ground station data shows that Ester Dome was cloudy during the rocket flight. Poker Flat was partly cloudy and Ft. Yukon was mostly clear during the launch of this rocket, but clouded up soon afterwards. Thus, only Ft. Yukon can be used for photometric data, and even then only partially. Due to cloudy skies, the Ester Dome optical data is not useable. Because of mechanical problems with the recording camera of the meridian scanning photometer system at Ft. Yukon no data was obtained except on an analog tape recorder which increases the complexity of obtaining photometric values for this event. However, all sky camera data at both Ft. Yukon and Poker Flat are useable for the general description of the auroral activity surrounding the launch of PF-HJ-NJ-90.

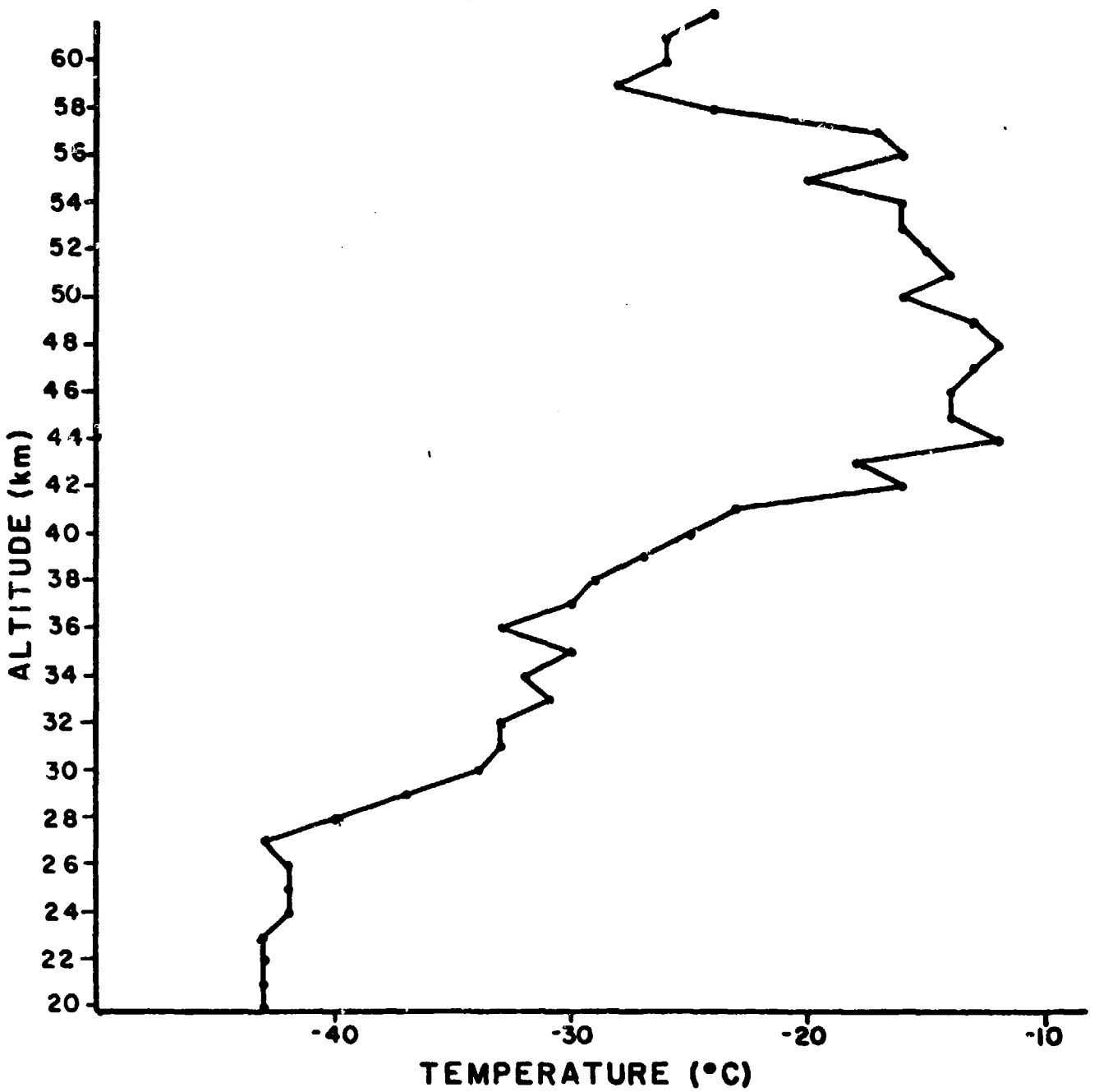


Figure 1 Temperature versus Altitude at Poker Flat

Section 3 - Solar and Lunar Data

Table 6 is a list of the geographic azimuth and elevation angles of the sun with respect to the true horizon on March 11, 1975 for Poker Flat.

TABLE 6 Solar Azimuth and Elevation

Station Location Lat - 65.13 Long = 147.48

UT Time	Azimuth	Elevation
0000	211.46	17.4256
0100	226.445	13.4814
0200	240.799	8.42691
0300	254.661	2.61585
0400	268.285	- 3.59442
0500	281.934	- 9.84908
0600	296.083	-15.7854
0700	310.871	-21.0224
0800	326.519	-25.1646
0900	342.989	-27.8362
1000	359.971	-28.7538
1100	16.9487	-27.81
1200	33.4092	-25.1128
1300	49.044	-20.9456
1400	63.8166	-15.6835
1500	77.9008	- 9.7211
1600	91.5855	- 3.43793
1700	105.199	2.80451
1800	119.056	8.65142
1900	133.412	13.7461
2000	148.412	17.7335
2100	164.021	20.2907
2200	180.008	21.1826
2300	195.998	20.3216
2400	211.618	17.7942

Table 7 is a list of the geographic azimuth and the elevation angles of the moon with respect to the true horizon for Poker Flat during March 11, 1975.

TABLE 7 Lunar Azimuth and Elevation

Station Location Lat = 65.13 Long = 147.48

UT Time	Azimuth	Elevation
0000	232.098	7.99178
0100	245.704	2.91675
0200	259.704	- 2.75219
0300	272.286	- 8.69215
0400	285.799	-14.5735
0500	299.851	-20.0503
0600	314.683	-24.7545
0700	330.401	-28.3074
0800	346.877	-30.3637
0900	3.72331	-30.6888
1000	20.3976	-29.2325
1100	36.4244	-26.1453
1200	51.5635	-21.7241
1300	65.8333	-16.3302
1400	79.4338	-10.3287
1500	92.6521	- 4.06496
1600	105.802	2.13464
1700	119.18	7.95099
1800	133.028	13.0619
1900	147.49	17.1459
2000	162.557	19.9056
2100	178.042	21.1141
2200	193.615	20.669
2300	208.921	18.6225
2400	223.705	15.1684

Section 4 - Magnetic Data and Indices

The magnetometer data from the stations listed in Table 8

TABLE 8 Location of Magnetic Observatories

	Geographic		Invariant		
Location	Latitude	Longitude	Latitude	Longitude	L
Pt. Barrow	N 71.60	W 156.4	N 66.9	W 109.35	8.47
Ft. Yukon	N 66.57	W 145.25	N 66.9	W 95.3	6.50
College	N 64.87	W 147.80	N 64.75	W 95.7	5.49

are presented in Figure 2a on the same time and magnitude scale for each of the three components of the magnetic field. The time of the rocket launch is indicated by a vertical line. The launch occurred 30 minutes prior to an 800γ negative bay in H at College. Figure 2b is the magnetometer data expanded around launch time.

Figure 2c presents the magnetometer data in terms of variations of the magnitude of Z and H components with latitude. These data indicate that the eastward auroral electrojet prior, during and shortly after the launch, occurred in a region south of College with a westward electrojet north of Ft. Yukon. During this period the pattern moved slightly equatorward keeping the same general configuration. The magnitude of the current density to a first approximation (∞ sheet current) in Amp/km is the same numerical value as the H component magnitude in gamma. The actual value may be as much as two or more times that deduced from the magnitude of the magnetometer data but the temporal variation will be similar.

Figure 3 shows the total K index, planetary Kp index and DST values for UT, March 11, 1975. During the rocket flight, Kp and K were 5 and 6, respectively.

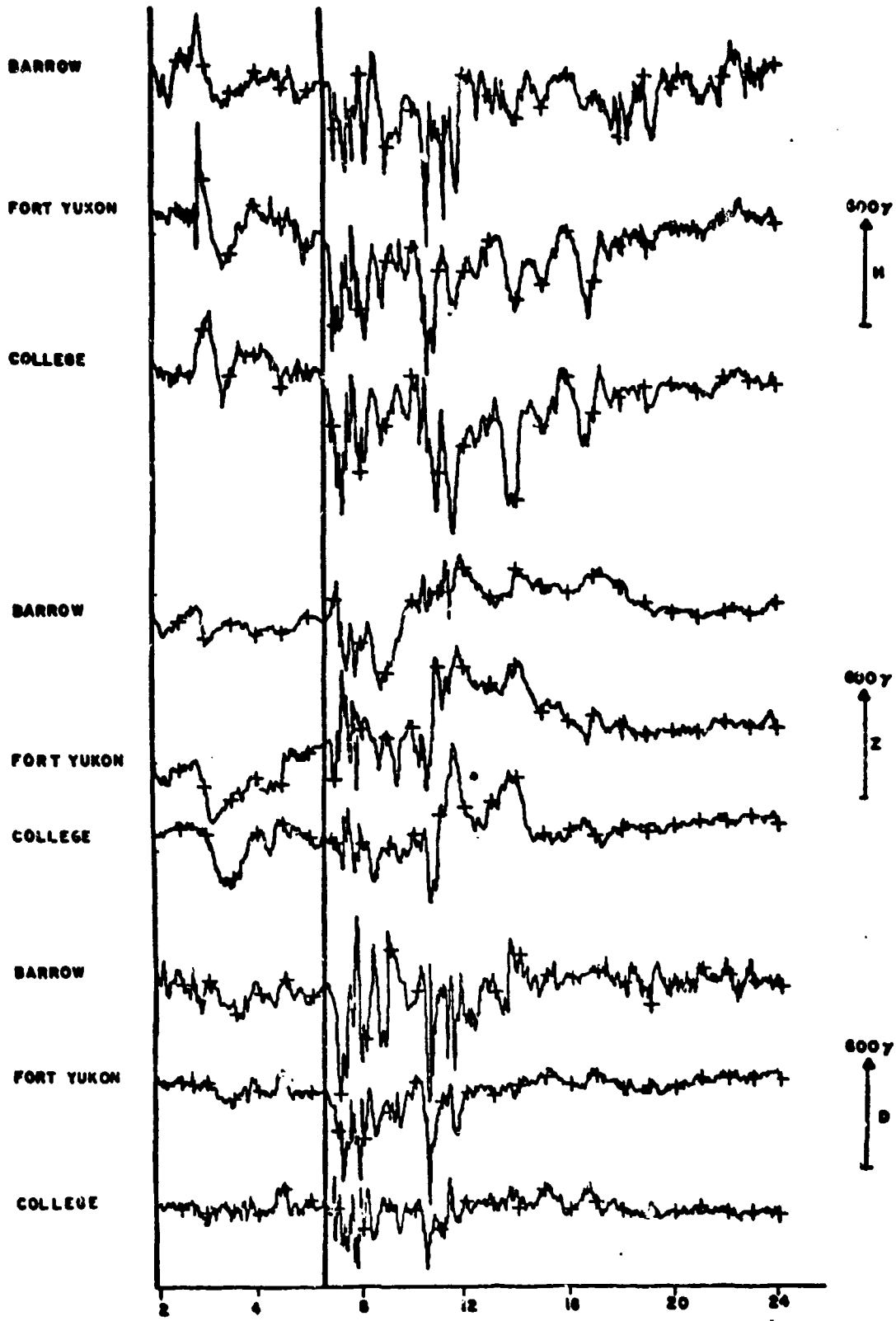


Figure 2a Magnetometer Data from Various Locations

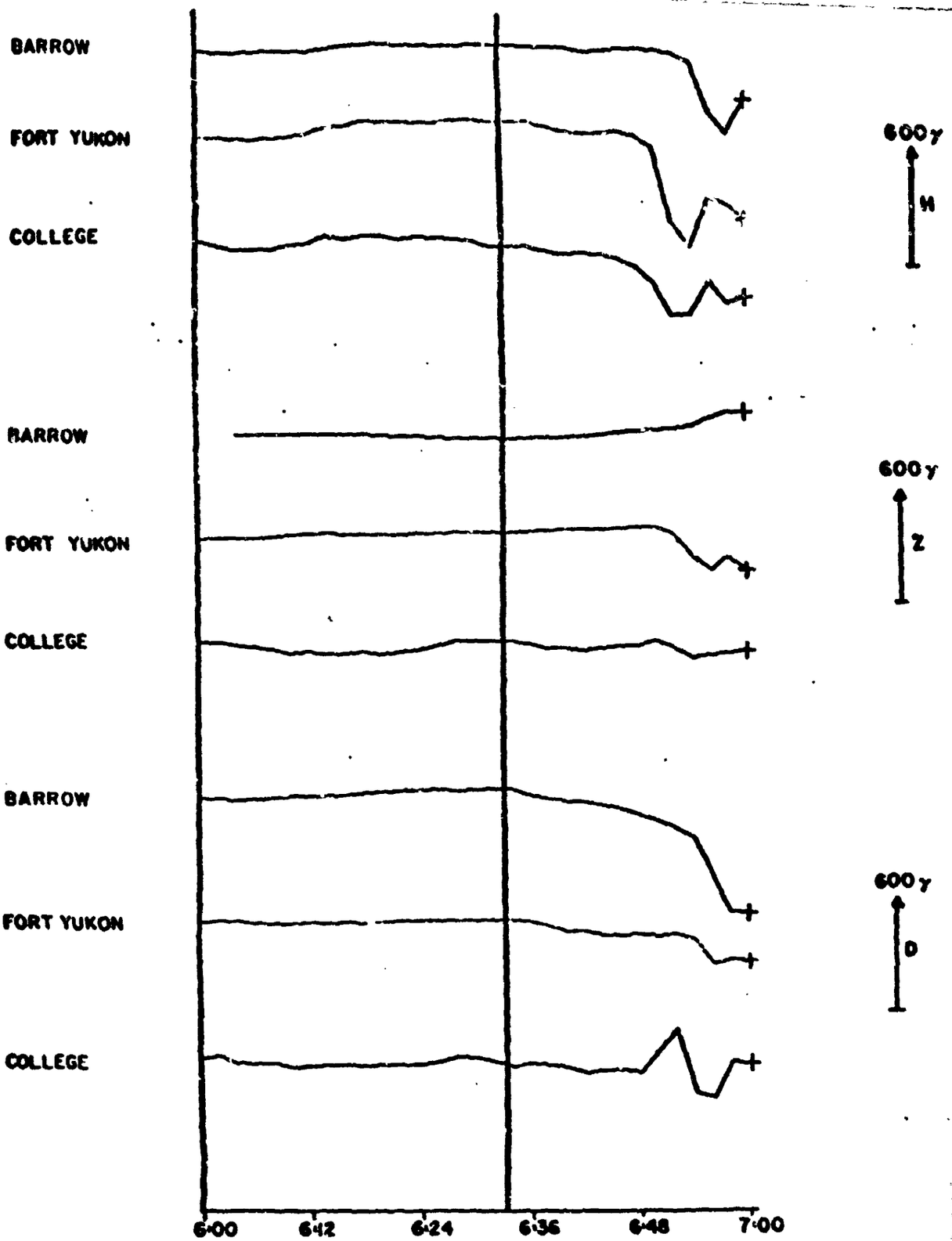


Figure 2b High Time Resolution Magnetometer Data from Various Locations.

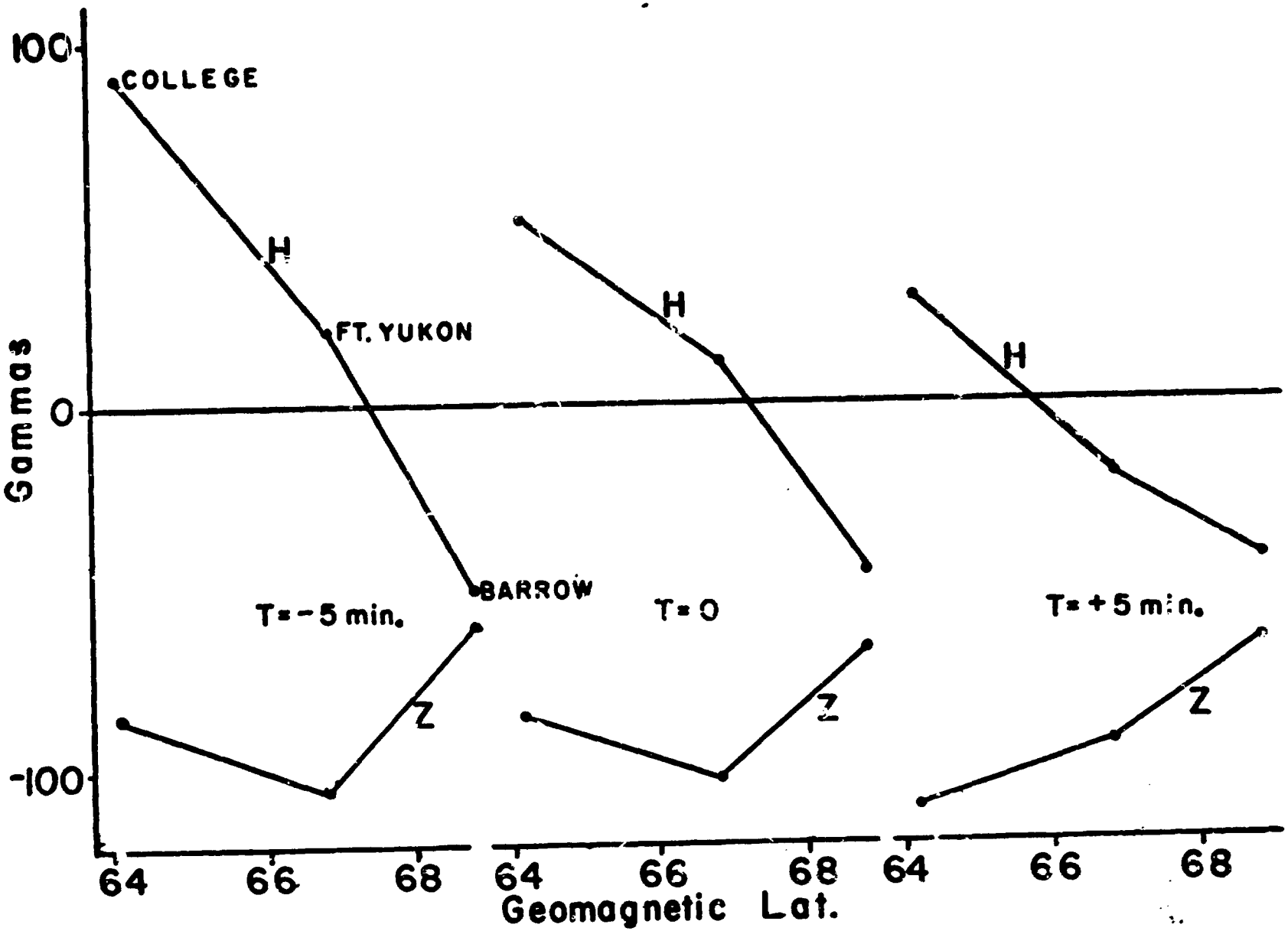


Figure 2c Variation of the Z and H Magnetic Components with Latitude

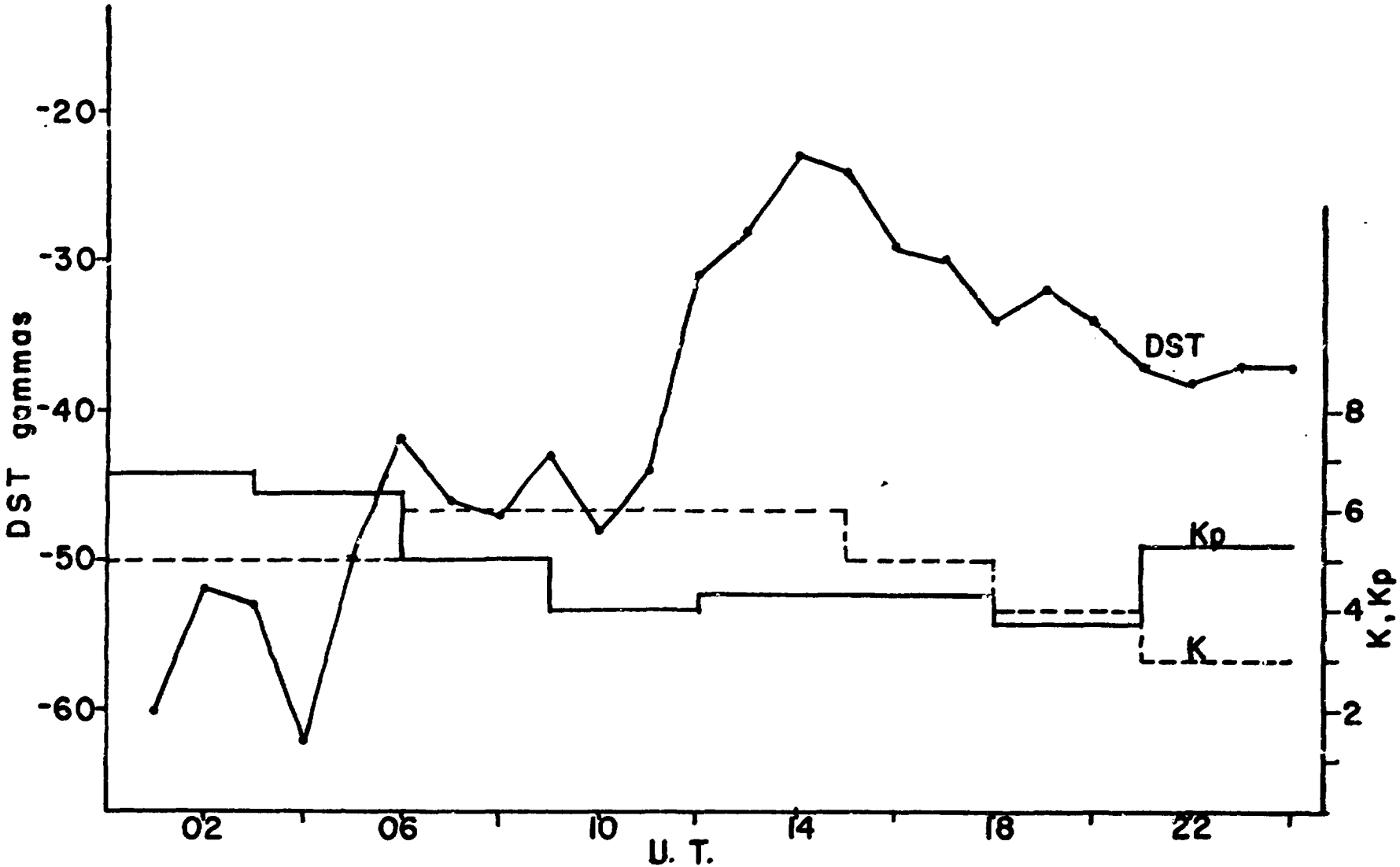


Figure 3 K, K_p, DST for March 11, 1975

The mean value of DST during four hours following the launch of this rocket was -45γ in a general decreasing negative trend for DST.

Figure 4 shows the position of the trapping boundary before and after substorm activity at various DST levels. At DST values of -40 to -45γ_s which occurred during this flight, the trapping boundary was probably south of Poker Flat; thus, the rocket probably traversed the region poleward of this boundary. It appears that the rocket was primarily in or just poleward of the eastward electrojet and sampled the region between the eastward and westward electrojets. NOAA 50 MHz radar data from Anchorage, Alaska, if available, could further clarify the picture. A further discussion of this type of magnetic disturbance, associated with the substorm picture and particle effects, can be found in the description of Polar and Magnetospheric Substorms, in the book by Akasofu, 1968.

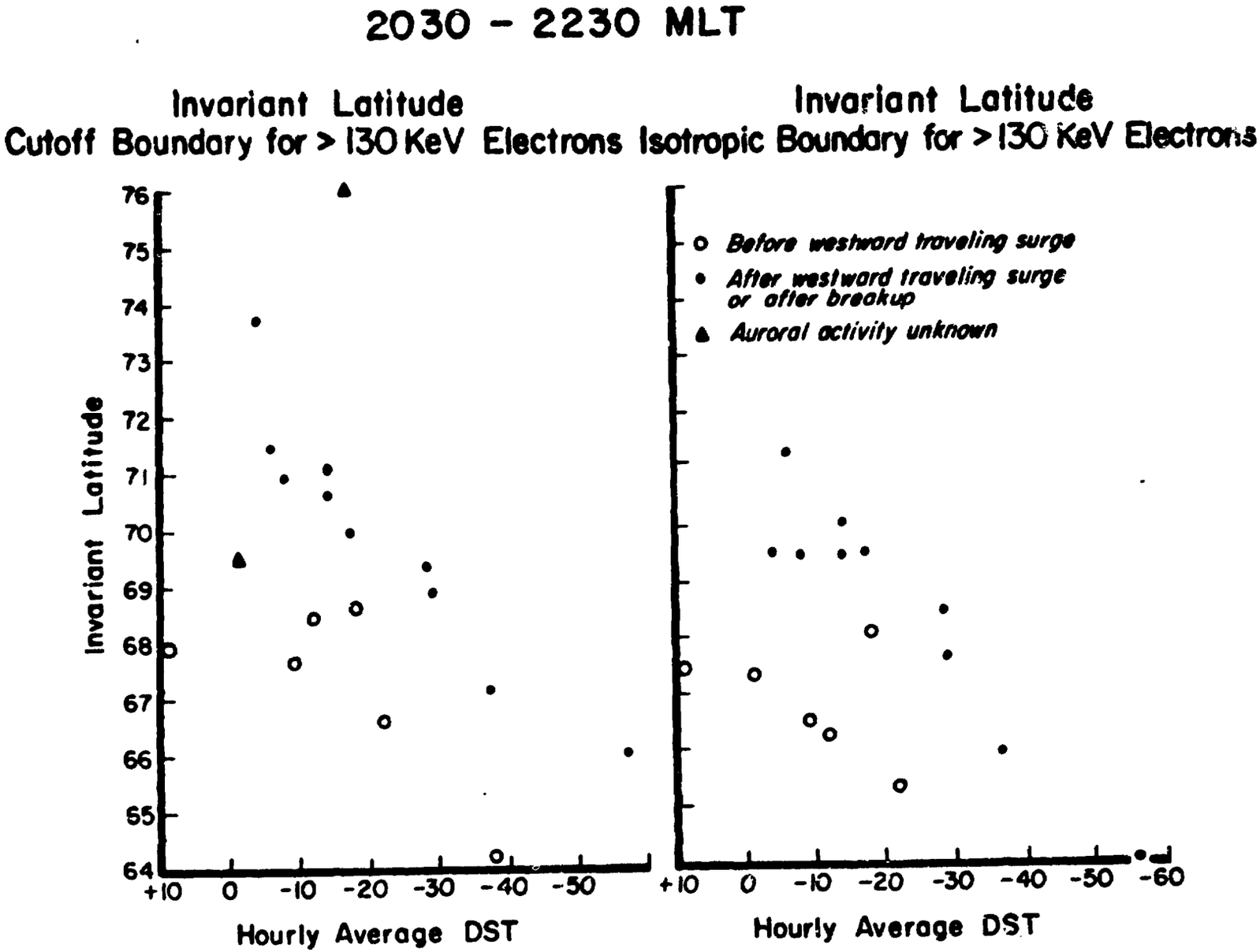


Figure 4 Latitudinal Variation in the Trapping Boundaries for > 130 kev electrons in the Evening Sector of the Auroral Oval as a Function of Dst, Before or After Substorm Activity.

Section 5 - Radar Observations

During this period in the spring of 1975 the 50 MHz NOAA radar at Anchorage was in operation on a routine basis. Resumes of their data, instrumentation, and operational details are available from NOAA in Boulder, Colorado. However, no data are available for the period ± 15 minutes around launch.

In addition, data from the Chatanika Incoherent Scatter radar are also available from SRI.

Any detailed study of the rocket data should incorporate a detailed examination of the available radar data. It is particularly applicable to the spatial structure of electron density irregularities, electric fields, neutral winds, and spatial and temporal dynamics of the particle precipitation.

Section 6 - All Sky Camera Observations

Table 9 lists the stations from which either 16mm or 35mm all sky camera and other instrument data are available during the period of interest on March 11, 1975. The auroral data quality from each site depends on the cloud coverage as indicated in Section 2.

Figure 5 is a composite of 35mm all sky camera photographs for the period prior to, during and after the launch of PF-HJ-NJ-90. Figure 6 is a composite of 35mm all sky camera photographs during launch.

The stations used were Ft. Yukon and Poker Flat. Time in UT as well as in seconds (or minutes) with respect to launch are indicated on each print.

From these photographs and a review of all of the data available, we describe the general auroral situation covering this rocket launch.

TABLE 9 Geophysical Instruments Operating
March 11, 1975

Chatanika

Incoh. Scat. Radar - 00:13-19:50 UT
35ASC - 04:58-15:04 UT
16ASC - Continuous

Fort Yukon

MSP - 06:11-09:30 UT
35ASC - 06:07-09:30 UT
16ASC - Continuous
Riometer - Continuous
Magnetometer - Continuous

Poker Flat

TV - 06:23-? UT
Magnetometer - Continuous
Riometer - Continuous

Ester Dome

MSP - 06:10-09:30 UT
35ASC - 06:32-09:30 UT
16ASC - Murphy Dome-Continuous
Hg Backscatter - Continuous

College

Riometer - Continuous
Magnetometer - Continuous
Ebert Spectrophotometer - 0530-12:30 UT
Zenith photometer - 05:30-12:30 UT

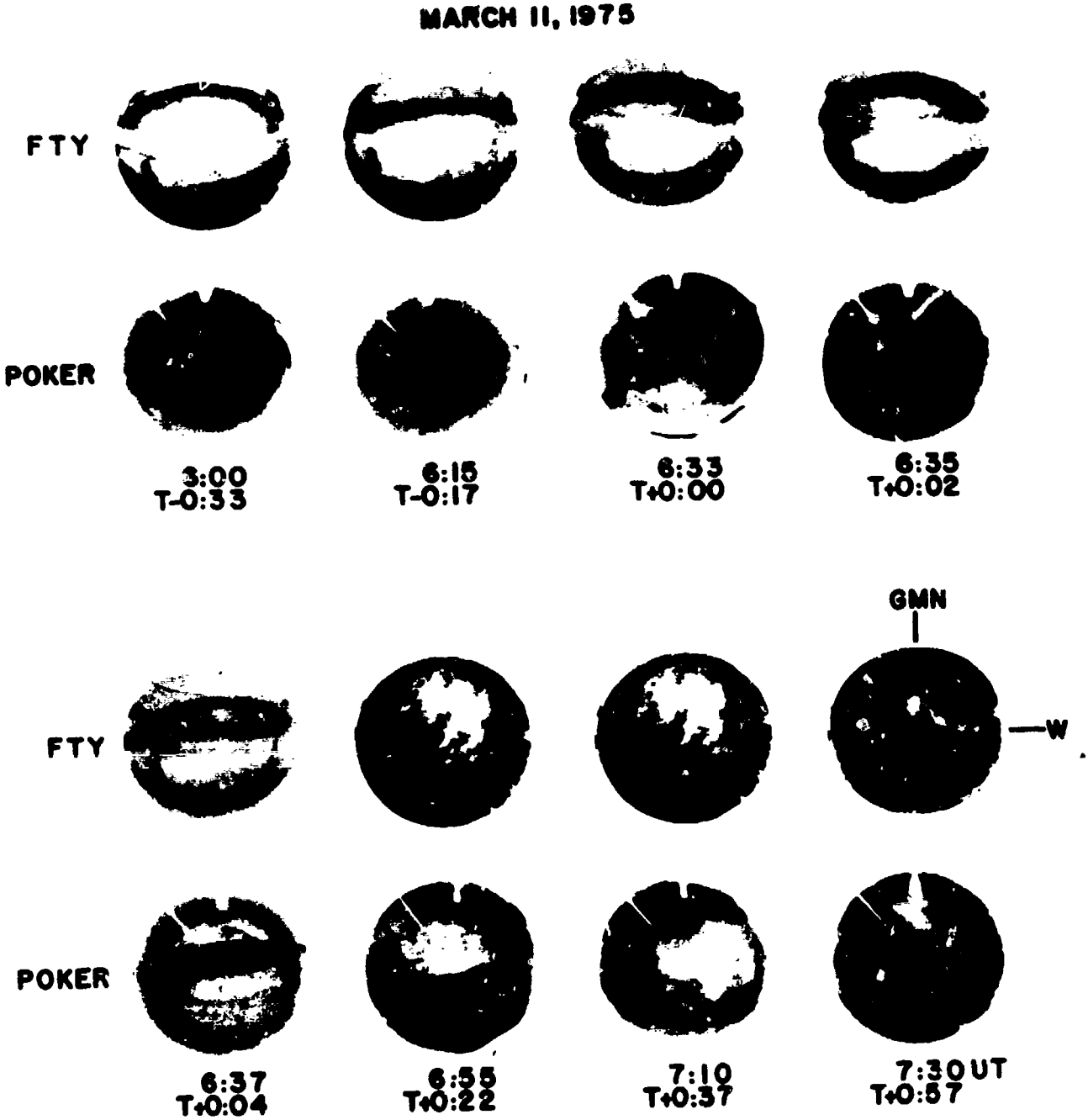


Figure 5 All Sky Camera Data Prior to, During and After Launch

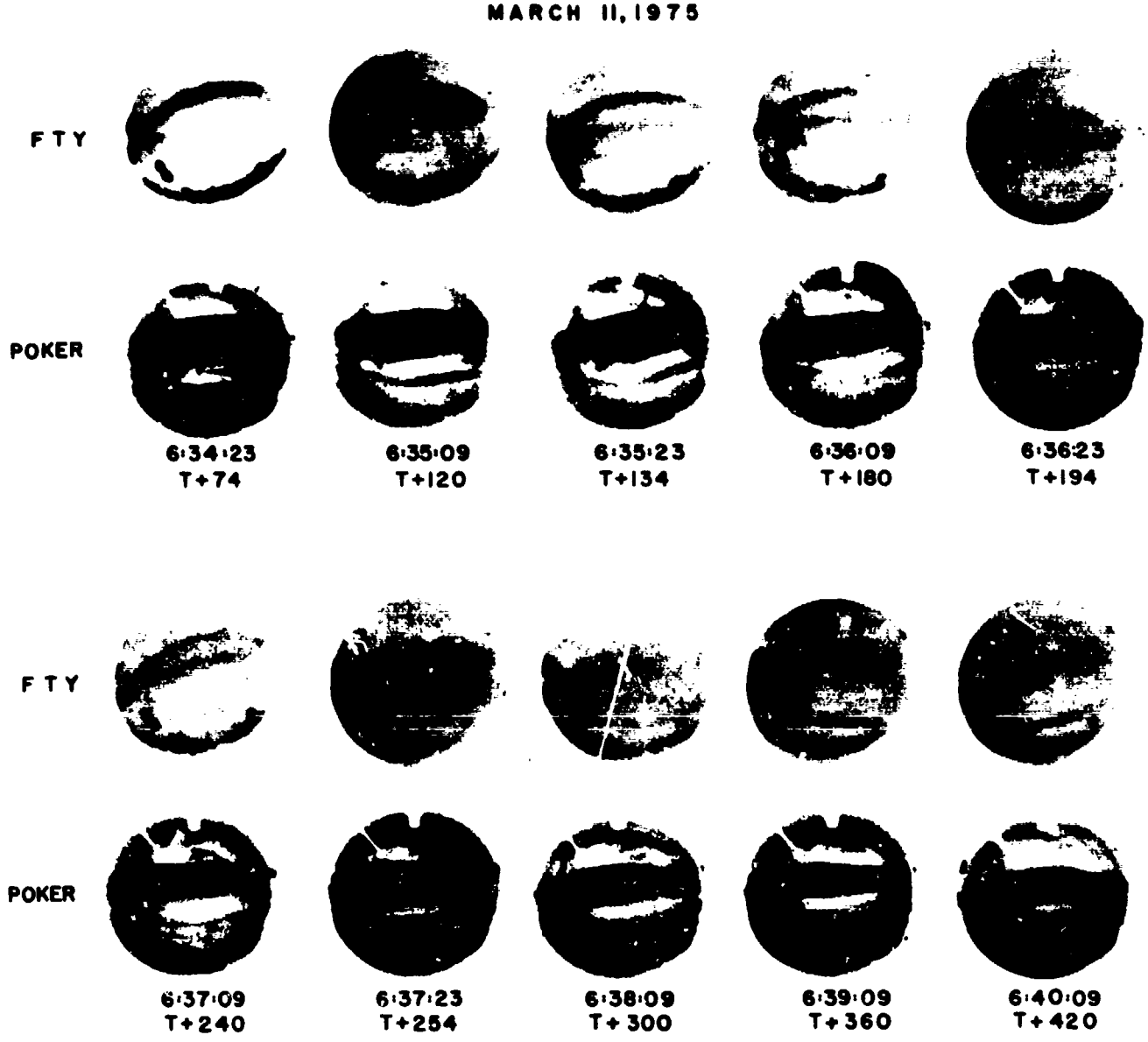


Figure 6 35mm All Skay Camera Data During Laun

Ft. Yukon All Sky Camera Data

0609	35mm ASC data initially shows a stable bright (IBC II to III) rayed arc in the south (60° zenith angle) with another weak arc (IBC I) in the north (60° zenith angle).
0630	Auroral activity has remained stable with the northern arc moving to 45° zenith angle. The southern arc has remained stable at 60° zenith angle.
0633	Continuation of same pattern.
0636	Arcs in both south and north have decreased in intensity considerably (IBC I), but have remained in the same location as seen from Ft. Yukon.
0639	Rayed arcs (IBC II) are located at 60° and 45° south of the zenith with a weak diffuse arc (IBC I) 20° north of the zenith.
0642	Single arc in south (IBC I^+) (60° zenith angle), another arc (IBC I) in the geographic zenith of Ft. Yukon.
0650	Aurora appears weaker in south $\sim$ 60°.
0700	Aurora in south begins to get very bright. It is now obvious that clouds obscure the aurora in south. However, at this time the aurora is so bright it shows through the clouds.
0710	Whole sky over Ft. Yukon is very bright through overcast sky.
0720	Aurora increases and decreases over cloudy skies for rest of the night. Data stop at $\approx$ 0930 at Ft. Yukon.

Poker Flat All Sky Camera Data

0600	Aurora barely visible through clouds.
0615	Clouds thinning and auroral arc overhead becoming visible.
0633	Bright arc north of zenith with thin narrow arc in magnetic zenith.
0635	Bright arc still north of zenith, thin multiple arcs in south, sky still cloudy.
0637	Sky somewhat clearer, arc north of zenith quite bright.
0655	Aurora and clouds intermixed.
0730	Bright aurora and cloudy sky continued until data stop at 0930.

Section 7 - Meridian Scanning Photometer

Meridian scanning photometers were operated at Ester Dome and Ft. Yukon during this rocket launch. However, clouds at Ester Dome prevent any use of these data. The data recording camera at Ft. Yukon failed during this launch; however, a back-up analog tape recorder was in use and did record useable photometric data. Because of the difficulty in using these analog tape records, no photometric data are included in this report. A further detailed study of this event could warrent the reduction of these data from Ft. Yukon. However, the scattered clouds at the beginning and increasing cloudiness during the event may make absolute intensities inaccurate.

Section 8 - Television Coverage

No television data from Ester Dome were obtained during this rocket launch.

Section 9 - Riometer Data

Riometers are operated at Ft. Yukon and College. Absorption is measured at 30 MHz. Figure 7 shows the records from 6:00 to 9:00 UT on March 11, 1975. There was very little absorption during the time interval of interest which indicates that no extensive flux of high energy particles were precipitating during this rocket flight. The exact values of absorption are accurate to $\pm$ 2 db for this level of activity.

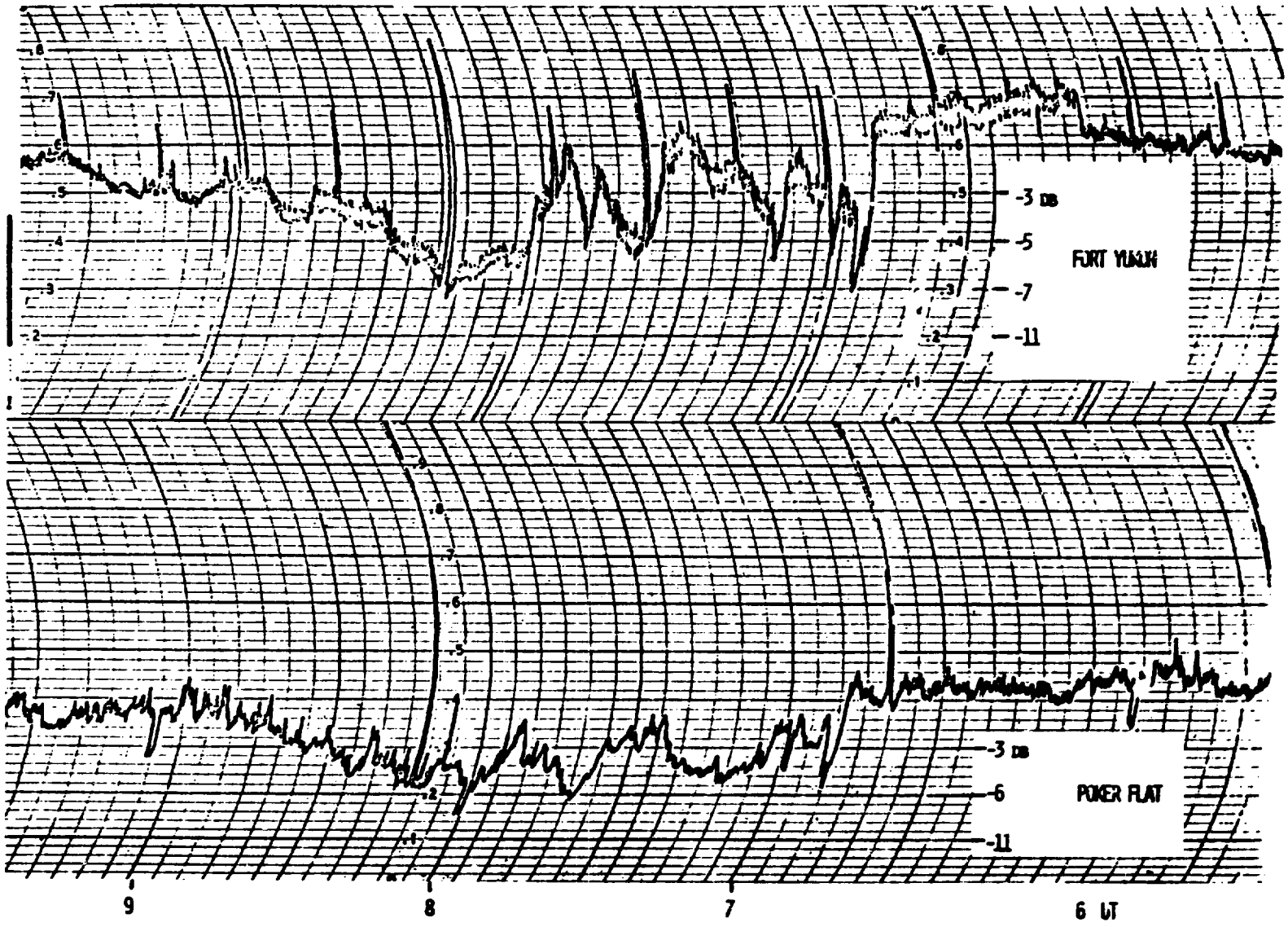


Figure 7 Riometer Absorption from Poker Flat and Ft. Yukon

Section 10 - Ionosonde Data

The ionosonde at College operates between .5 and 20 MHz at vertical incidence. It requires approximately 30 seconds to sweep over the complete frequency range and is normally programmed to operate once every 15 minutes, on the minute. Data for the 3 periods closest to launch are presented here. These data illustrate typical sporadic E_s signals. The f_0E_s on the three recordings represent peak electron densities of 1.0×10^6, 1.8×10^6 and 0.9×10^6 electrons/cm^3 and shows the influence of the bright arc which developed around 0630 into which rocket PF-HJ-NJ-90 was launched.

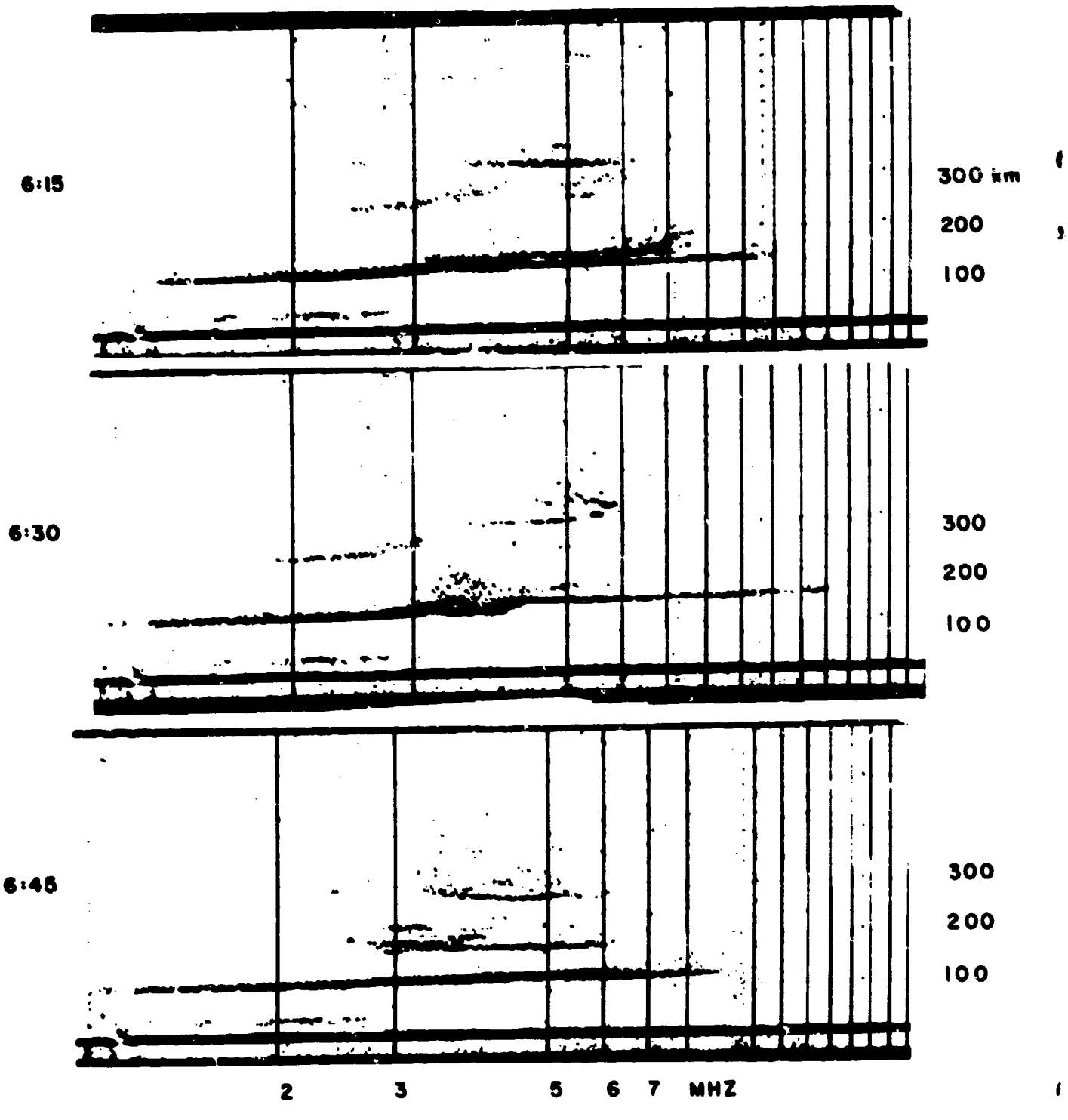


Figure 8 Ionosonde Data from Collene

Section 11 - DMSP Satellite Photographic Data

The Air Force weather DMSP satellites record auroral activity on nighttime passes over the auroral zone. We have included in Figure 9 the closest satellite pass to the launch of Rocket PF-HJ-NJ-90. This satellite pass crossed the equator at 08:57:30 at an east longitude of 176.36°. A map of Alaska is superimposed on the satellite photograph for orientation purposes. Since this pass was approximately two hours after the launch of PF-HJ-NJ-90, it is not useful in assessing the activity during this period of interest however, it does indicate the type of data which could be useful in future programs.

Figure 9 DMSP Satellite Photograph at 08:57:30 UT, March 11, 1975

References

Akasofu, S.-I., Polar and Magnetospheric Substorms, D. Reidel Publishing Company, Dordrecht, Holland, 1968.

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